

SRB CRITICAL ITEMS LIST

SUBSYSTEM: STRUCTURES AND MISCELLANEOUS ITEMS

ITEM NAME: Frangible Nut

PART NO.: 10306-0001-801, -802, -803  
10306-0003

FM CODE: A02

ITEM CODE: 60-04-03

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Immediate

NO. REQUIRED: 4 per SRB

DATE: March 1, 2001

CRITICAL PHASES: Final Countdown

SUPERCEDES: March 31, 1998

FMEA PAGE NO.: E-56

ANALYST: S. Parvathaneni

SHEET 1 OF 4

APPROVED: S. Parvathaneni

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FAILURE MODE AND CAUSES: Premature fracture caused by:

- o Improper threads
- o Thin Web
- o Improper Heat Treat
- o Defective Material
- o Excessive Preload

FAILURE EFFECT SUMMARY: Premature operation of a holddown frangible nut would result in release of one SRB/MLP holddown assembly. This would result in vehicle instability on the pad during SSME thrust build-up resulting in an ET fire and explosion and loss of mission, vehicle and crew.

RATIONALE FOR RETENTION:

A. DESIGN

- O The frangible nut design specification is USA SRBE 10SPC-0030.
  - o Threads are buttress type per FED-STD-H28/14 (N-BUTT 1 Modified)
  - o Limit load per paragraph 3.3.1 of USA SRBE 10SPC-0030. (Thin Web, Improper Heat Treat, Defective Material)
    - 1,135,000 lbs. min. for 10306-0001-801 (KSC)
    - 1,144,000 lbs. min. for 10306-0001-802, 803 (KSC/VAFB)
  - o Ultimate load per paragraph 3.3.1 of USA SRBE 10SPC-0030.
    - 1,512,000 lbs. min. for 10306-0001-801 (KSC)
    - 1,602,000 lbs. min. for 10306-0001-802, 803 (KSC/VAFB)
- O Material is Inconel 718 per AMS 5664 (Improper Material)

- O Heat Treated per MIL-H-6875 and 10PRC-0631
- O Qualification
  - o Repeated assembly onto a stud with no thread damage. (Thread Failure)
  - o Ultimate load test with nut assembled on stud. (All Failure Causes)
  - o Limit load test with nut assembled on stud. (All Failure Causes)
  - o Qualification is documented in Space Ordnance Systems Report QTR 8660/9210 or Pacific Scientific Energy Systems Division QTR ER-PYR-96-002. (All Failure Causes)
  - o Qualification of alternate source (UPCO) frangible nut manufactured using existing SOS documentation is documented in ER-PYR-91-001. (All Failure Causes)
  - o USA SRBE COQ A-PYR-6108, A-PYR-6125 and A-PYR-6134-1
  - o Qualification of alternate frangible nut is documented in Pacific Scientific Energy Systems Division report ER-PYR-96-002. (All Failure Causes)

B. TESTING

- O Lot Acceptance Test per Space Ordnance Systems Procedure ATP 8793, or Pacific Scientific Energy Systems Division ATP 10306-0003.
  - o Dimensional examination of entire lot. (Thread, Web)
  - o Dye penetrant inspection of entire lot. (Defective Material)
  - o Acceptance load test of entire lot. (All Causes)
  - o Ultimate load test of 2 samples per lot. (Web, Heat Treat, Material)
- O Lot Acceptance Test is performed with a 540,000 pound stud preload and web thickness of 110% of actual thickness demonstrates that the frangible nut will perform per specification requirements in flight. (BI-1992)

C. INSPECTION

VENDOR RELATED INSPECTIONS

O RECEIVING

- o Raw material certification and test reports are verified by USA SRBE Quality Assurance, Contractor Quality Assurance per: (Improper Heat Treat, Defective Material)
  - o USA SRBE Quality Assurance
    - USA SRBE SIP 1155/1469
  - o Contractor Quality Assurance
    - Space Ordnance Systems Manufacturing Procedures 114850-9, 114850-11 and 114850-13.
    - Pacific Scientific Energy Systems Division Receiving Inspection operation sheet 10306-0005.

- O Web dimension, nut dimension, heat treatment (coupons), and threads are inspected one hundred percent by Contractor Quality Assurance and verified by USA SRBE Quality Assurance per: (Improper Dimension)
  - o USA SRBE Quality Assurance
    - USA SRBE SIP 1469
  - o Contractor Quality Assurance
    - Space Ordnance Systems Quality Acceptance Inspection Procedures USA SRBE-0014 and USA SRBE-0015.
    - Pacific Scientific Energy Systems Division Inspection operation sheet 10306-0004.
- O Acceptance load test and penetrant inspection are witnessed one hundred percent by contractor Quality Assurance and verified by USA SRBE Quality Assurance per: (Heat Treat, Web, Material)
  - o USA SRBE Quality Assurance
    - USA SRBE SIP 1155/1469
  - o Contractor Quality Assurance
    - SOS MP 114850-9 and SOS ATP 8793.
    - Pacific Scientific Energy Systems Division Inspection operation sheet 10306-0004 and ATP 10306-0003.
- O Microstructure evaluation at 500X magnification of either the nut forging or the "A" forging coupon is performed one hundred percent by Contractor Quality Assurance per: (Improper Heat Treat Defecting Material)
  - o SOS MP 114841-5, -9
  - o USA SRBE Drawing 10306-0005
- O Ultimate load test is witnessed one hundred percent by USA SRBE Quality Assurance and Contractor Quality Assurance per: (Web, Heat Treat, Material)
  - o USA SRBE Quality Assurance
    - USA SRBE SIP 1469
  - o Contractor Quality Assurance
    - Space Ordnance Systems Acceptance Test Procedure 8793.
    - Pacific Scientific Energy Systems Division ATP 10306-0003.
- O Lot review and certification per USA SRBE Plan 10PLN-0030. (Improper Material)
- O Critical Processes/Inspections: The following critical processes/inspections are used to assure structural integrity of the Frangible Nut:
  - o Heat Treatment per MIL-H-6875 and 10PRC-0631. (Improper Heat Treatment)
  - o Ultrasonic Inspection per MIL-STD-2154 (Defective Material)
  - o Penetrant Inspection per MIL-STD-6866. (Defective Material)
  - o Microstructure evaluation at 500X magnification per SOS MP 114841-5, -9 or USA SRBE DWG 10306-0005. (Defective Material Improper Heat Treat)

## KSC RELATED INSPECTION

- O Receiving Inspection
  - o Lot and serial number of each pyro device listed on the certification statement document is verified per OMRSD File V, Vol. 1, requirement number B000FL.002. (Improper Heat Treat, Defective Material)
- O Frangible Nuts Inspection is performed per 10REQ-0021 Para. 4.9 prior to transfer. (Defective Material)
- O Installation Inspection
  - o Installation is witnessed one hundred percent by SPC Quality in accordance with 10100-0049 (SRB Aft Boosters to MLP installation). (Improper Threads)
  - o Verification of preload per File V, Vol. I, requirement number B08HS0.033. Maximum stud load shall not exceed load application and cycle limits as defined in OMRSD File II, Vol. III, Table C00CB0.060-000. (Excessive Preload)
  - o Verification of holddown stud and nut tension at launch pad File V, Vol. I, requirement number B08HS0.040. (Excessive Preload)
  - o Verify stud and nut thread condition per File V, Vol. I, requirement number B08HS0.060. (Improper Threads)

## D FAILURE HISTORY

- o Failure Histories may be obtained from the PRACA database.

## E OPERATIONAL USE

- o Not applicable to this failure mode.

## F. WAIVERS

- o BI-1992, 6-25-97, CCB0 SB3-01-5166
  - o Requirements: 10CEI-0001 para 3.2.1.9.2.9 requires that "the Frangible nut shall meet the requirements of 10SPC-0030." 10SPC-0030 para 3.2.1.2 requires that upon detonation of one or both booster cartridges, the nut shall be completely severed into at least two sections, producing a minimum of fragmentation when separated. The stud shall be completely free from the nut upon detonation of one or both cartridges.
  - o Departure: During Lot Acceptance Test firings for Lot AAN Frangible Nuts, S/N 2000302 "Clam Shelled" open 2.7 inches but did not break into two sections. The stud was released.
  - o Rational: The web dimensions on the test units are required to be 110% of the design allowables to demonstrate margin. Web dimensions of Lot AAN test units were re-machined to 109.8% of design allowables, but are 110% of the actual web thickness represented in Lot AAN flight units. Successful re-performance of Lot Acceptance Testing with re-machined webs meets intent of margin requirement.

- BI-1998, 10-6-98, CCBD SB3-01-5254, Effectivity: BI 103 – BI 110
  - Requirements: 10CEI-0001 para 4.0 requires that "SRB and Associated launch essential support equipment shall meet the requirements of 10SPC-0030. 10SPC-0030 paragraph 4.1 states that the quality assurance program shall be in accordance with the requirements of NHB 5300.4(1C) and NSTS 5300.4(1D-2). NHB 5300.4(1C) section 1C310, defines " Measurement standards and equipment shall be selected and controlled to the degree necessary to meet contract requirements" Para 4.G also states " controls shall be established to ensure the immediate recalibration or removal from service of those (standards and equipment) found to exceed the established interval or which for any reason may have an adverse affect on quality".
  - Departure: The Gilmore universal test fixture at MSFC was calibrated for a range of tensile load up to 1.2 million pounds. Qualification testing for the SRB Holddown system Frangible Nut requires loads of 1.602 Million Pounds minimum.
  - Rational: The Gilmore machine was calibrated on March 3, 1998 my MSFC and tagged with a loading accuracy of <1% of range. Prior to each Frangible Nut test, the shunt calibration check point verifies the integrity of the load cells. Verification of the check point and calibration linearity from the load cell manufacturers guarantees a loading accuracy error of <1% to 3 Million pounds, tension or compression on the Gilmore.

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